E-WQ-74-2

TENNESSEE VALLEY AUTHORITY

TVA WATER QUALITY MONITORING NETWORK

DIVISION OF ENVIRONMENTAL PLANNING

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Water Quality Branch

Chattanooga, Tennessee

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TVA WATER QUALITY MONITORING NETWORK

CONTENTS

Figures

Tables

TVA WATER QUALITY MONITORING NETWORK

Introduction

The Tennessee Valley Authority (TVA) has established a water quality monitoring network throughout the Tennessee Valley to fulfill legal and program requirements for basic data. Water is a basic component that affects all natural and man-made processes. Its quality can be controlled with existing technology as long as adequate information is available. The network is designed to maintain an adequate data base by taking advantage of personnel who are already strategically located throughout the Valley to collect water samples. Supplies are shipped to field locations on a set schedule, and water samples are returned to a central laboratory for analysis. Samples are shipped by existing carriers, including TVA mail, the United States Postal Service, United Parcel Service, and bus package express.

Purpose

The purpose of this activity is to acquire systematically and efficiently data on water quality in a large geographical area to meet the basic needs of a variety of users. The data will serve as a basis for decision-making for the design and control of improved water quality. Specific objectives of this activity are to

1. Provide up-to-date information on existing water quality conditions for long-range planning of resource development programs and the power program;

2. Determine long-term trends in water quality conditions in the Tennessee Valley;

3. Provide a framework within which data collected for other studies can be kept up to date;

4. Supply short-term data needs as they are identified; and

5. Complement monitoring programs carried out by state and other Federal agencies to increase overall effectiveness.

Bases

The primary basis for the acquisition of water quality data is founded on TVA's responsibilities for resource management and regional development as expressed in section 22 of the Tennessee Valley Authority Act of 1933.[1] The regional water quality management program, which helps to implement these responsibilities, has as its primary purpose the achievement and maintenance of suitable water quality throughout the Valley to permit optimum use of surface and ground waters for municipal, industrial, and agricultural water supplies, for propagation of fish and wildlife, for esthetic enjoyment, for water-contact recreation, and for future development of streams and reservoirs in the public interest. The mission of the program is to keep all waters clean and free of pollution.

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1. "Tennessee Valley Authority Act of 1933," 16 U.S.C. sec. 831.

Since 1936, in collaboration with state and Federal agencies, TVA has conducted extensive stream studies, identified sources of pollution, and encouraged and assisted states to develop stream pollution control programs, which they are now actively carrying out in the seven Valley states. TVA continues to collaborate in water quality management with state and Federal agencies, local government institutions, and organizations concerned with industrial, community, and regional development in the Valley.

The TVA regional water quality management program was recently revised significantly to align program activities with the requirements and intent of the comprehensive Federal Water Pollution Control Act Amendments of 1972 (FWPCA of 1972).[1] The emphasis of the program is now on evaluating the effects on water quality associated with the TVA water resource system and its operation. These efforts are directed toward developing procedures for reservoir operation and management that will produce the most beneficial effects on water quality and thus contribute to TVA's goals for regional development. TVA's water quality monitoring network is designed to be an efficient means for supplying the basic data needed to attain these goals.

The National Environmental Policy Act of 1969 requires environmental statements for ". . . major Federal actions significantly affecting the quality of the human environment . . ."[2] Environmental statements are required for such projects as new highway construction and highway relocations, stream channelizations for flood control, water resource structures, and electric-power generating facilities. Nearly all such actions have an impact on water quality, and knowledge of existing water quality conditions is usually necessary for an intelligent assessment of this impact to be made.

Planning for TVA's power program is especially important because major decisions are required many years in advance of operation—in fact, during the earliest stages of site selection. Up-to-date water quality data must be available for a minimum of one year, and preferably for three years, at locations identified as potential sites to allow adequate and complete evaluation of site alternatives. Alternative site evaluation is required by the Atomic Energy Commission (AEC) for environmental reports submitted to them for their use in preparing environmental statements before construction of a nuclear power plant.[3]

Environmental Protection Agency (EPA) guidelines for administering the FWPCA of 1972 recommend that water quality surveys "be repeated at appropriately defined intervals."[4] With existing resources of personnel and money, it is impractical to conduct field surveys of the entire Valley or even throughout one state on an appropriate recurrence interval (e.g., every five years), but it is feasible to collect much of the needed information by means of a monitoring network. Detailed surveys in problem areas can supplement data from the monitoring network as needed.

The TVA water quality monitoring program is consistent with the language and intent of the FWPCA of 1972. Section 104 of FWPCA of 1972, which deals with research,

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1. "Federal Water Pollution Control Act Amendments of 1972," 33 U.S.C. sec. 1151.
2. "National Environmental Policy Act of 1969," 42 U.S.C. sec. 4331.
3. Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Plants," U.S. Atomic Energy Commission Directorate of Regulatory Standards, March 1973.
4. 40 CFR Part 131, Environmental Protection Agency, Proposed rules for the preparation of Water Quality Management Plans, 40 CFR Part 131, sec. 131.303, Federal Register, vol. 38, no. 99, May 23, 1973.

investigations, training, and information, directs EPA to establish programs in cooperation with the states and other Federal agencies to "establish, equip, and maintain a water quality surveillance system for the purpose of monitoring the quality of the navigable waters. . .and the Administrator shall, to the extent practicable, conduct such surveillance by utilizing the resources of NASA, NOAA, USGS, and the USCG . . . ."[1] This section also directs EPA to "collect and disseminate, in cooperation with other Federal departments and agencies, and with other public or private agencies, institutions, and organizations having related responsibilities, basic data on chemical, physical, and biological effects of varying water quality and other information pertaining to pollution and the prevention, reduction, and elimination thereof."[2] EPA, "after consultation with appropriate Federal and state agencies, and other interested persons, shall develop and publish" periodically information on water quality[3] and shall "provide for the maximum utilization of the appropriate programs authorized under other Federal law . . . for the purpose of achieving and maintaining water quality . . . ."[4] Section 305, entitled "Water Quality Inventory," requires EPA "in cooperation with the states and with the assistance of appropriate Federal agencies . . ." to prepare a comprehensive report describing water quality conditions during 1973 including an inventory of all point sources of discharges of pollutants." This section then provides that each state shall update this report annually and submit it to EPA by January 1 of each year. EPA then is to transmit the states' reports, together with EPA's analysis of the progress reported by the states, to Congress by October 1.[5] Section 501 deals with administration of the FWPCA of 1972 and allows EPA to utilize any Federal agency, with its consent, to assist in carrying out the purposes of this act.[6]

The network activity indirectly complements other program elements and administrative objectives by utilizing TVA personnel more efficiently, thus easing the impact of manpower restrictions on TVA programs. Although not originally designed with an energy shortage in mind, the network activity is responsibly compatible with the energy conservation objectives of TVA and the Nation.

Background

Possibly the most important and valuable activity in the TVA regional water quality management program is the monitoring of water quality conditions throughout the Tennessee River basin to maintain an up-to-date inventory that will adequately meet many of the requirements of those who need and desire such information. It was the activities of this program that provided the basic data used in preparing the three-volume report, "Comprehensive Plan for Water Quality Management in the Tennessee Valley—Water Quality, Including Needed Improvements, in the Tennessee Valley—1969."[7] Water quality data are provided daily to other groups in TVA for a wide variety of uses, and data are routinely provided to other agencies for use in their regulatory activities (evaluating the suitability of surface waters as a source of public and industrial water supplies, selecting areas for recreational development, and approving waste discharge locations).

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1. FWPCA of 1972, sec. 104 (a) (5).
2. Ibid., sec. 104 (b) (6).
3. Ibid, sec. 304 (a) (2).
4. Ibid., sec. 304 (j) (1).
5. Ibid., sec. 305.
6. Ibid., sec. 501 (b).
7. Compiled for planning by TVA and state regulatory agencies (out of print). A one-volume condensation of this report is available: "Water Quality in the Tennessee Valley," TVA Division of Environmental Planning, Water Quality Branch, Chattanooga, Tennessee, June 30, 1973.

TVA's fairly extensive and up-to-date inventory of water quality data in the Tennessee Valley is one of the principal sources of information available to the Valley states for preparing the basin plans required by the FWPCA of 1972. Direct requests for water quality data and related information are also received from colleges and universities, consultants, industries, and individuals. All of TVA's water quality data are entered into the data storage and retrieval system (STORET) operated by EPA. Because of the great number of users who have access to the STORET system, there is no way to document the full extent to which TVA water quality data are used.

Over the past several years, many steps have been taken to improve the effectiveness and efficiency of this program. The type and number of analytical determinations that can be performed in the Water Quality Branch laboratory have been increased. Instruments have been purchased to replace costly, time-consuming, manual wet-chemistry analytical determinations and, where feasible, to automate the analysis of water samples. In the past few years, the number of water quality parameters analyzed and the total number of water samples handled has increased without a corresponding increase in cost.

Field staff from other TVA organizations have been utilized more and more to collect water samples while they carry out their other assignments. Personnel from the TVA Hydraulic Data Branch have been equipped and trained to perform basic water quality determinations in the field and to collect water samples for more complete analysis in the laboratory. These efforts have increased capabilities for water sampling and field investigations with little—or, in many cases, no—increased cost.

The water quality monitoring network concept is an expansion of existing activities that experience has shown to work well. Since 1950, data on temperature and dissolved oxygen (DO) have been collected at most of the hydroelectric plants and dams throughout the Tennessee Valley (during recent years, at 33 locations). Samples are collected by operating personnel at each plant, and the pretreated samples are mailed to the TVA Water Quality Branch laboratory in Chattanooga, Tennessee, for analysis. A sampling program to catalog mineral quality of surface waters has been carried out principally by the Hydraulic Data Branch over the past 30 years. Since 1966, the United States Geological Survey (USGS) has cooperated with sample collection, and since 1969 the TVA Water Quality Branch laboratory has provided analytical support. In addition, personnel from a number of TVA organizations have cooperated in the collection of water samples for special purposes. Experience has shown that cooperative sampling activities are successful as long as adequate administrative and technical support are provided.

The network approach also fits well with other program activities. For example, Hydraulic Data Branch personnel are equipped to provide, under direction from the Water Quality Branch, preliminary, prompt investigation of reported fish-kills and other "emergency" incidents related to water quality. Such investigations, by their very nature, are intermittent and infrequent and pose special problems in training personnel to maintain readiness. The regular collection of water samples for the network activity, with the continual training and constant practice associated with it, complements the objective of maintaining a team capable of prompt response. Another example of complementary activities is the sampling of raw water intakes, which was recently initiated at all steam plants in partial compliance with EPA and state regulations. The periodic sampling required for this purpose has been broadened—without cost to the power program—to encompass the broader objectives of the network activity.

Network Design and Operation

The water quality monitoring network consists of several interrelated components. Weekly sampling for temperature and DO at 33 TVA and Alcoa hydroelectric plants and dams, which has been conducted for several years, is continued without change. In addition, personnel at the same 33 locations began (in January 1974) monthly sampling for sanitary-chemical and mineral analyses. Water samples are collected quarterly for more complete analysis at 45 locations in the Tennessee Valley (and 8 locations outside the Valley). The stations sampled quarterly are located at several of the hydroelectric and steam plants, and at municipal water treatment plants and stream gaging stations. All of these stations—sampled weekly, monthly, and quarterly—are established for long-term data collection. This listing of long-term stations will be reviewed periodically and revised as different needs are identified. To provide flexibility for the network, additional stations are selected for sampling on a monthly frequency for a 12-month period. These stations are reevaluated annually to provide water quality data responsive to changing needs. Thirty-four stations are being sampled currently.

Weekly and Monthly Sampling at Hydroelectric Plants and Dams

Temperature and DO have been monitored weekly at TVA and Alcoa hydroelectric plants and dams since 1950. This activity is being continued unchanged. The 33 locations now being sampled are identified in table 1, and shown in figure 1 (this list has changed slightly from time to time). This weekly monitoring involves measuring water temperature with a hand thermometer and collecting and pretreating a DO sample according to the modified Winkler procedure.[1] The sample is carried through the acidification stage and then mailed to the Water Quality Branch laboratory for titration. Samples are titrated within 24 to 48 hours after collection. Field checks show that the delay in titration has little or no effect on the accuracy of the results.

Monthly collections of water samples were begun in January 1974 at the same locations sampled weekly (table 1 and figure 1). Collection of these monthly samples involves only filling five bottles with water, which is usually done in conjunction with the weekly sampling. Samples are analyzed for the parameters listed in table 2. Parameter selection was based on the following considerations:

1. General usefulness of the parameter to describe basic water quality.

2. Concentration of the parameter is not seriously changed by a one- to two-day delay in measurement, or concentration can be protected by adding a chemical preservative.

3. Capability of the laboratory to analyze the parameter efficiently on a mass basis.

Sample bottles are shipped by United Parcel Service (UPS) to each of the hydroelectric plants during the week before the desired collection date. Before shipment, preservatives are added to the bottles to be used for analysis of chemical oxygen demand and the nitrogen series to ensure stability of these parameters. Instructions stipulate that

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1. "Methods for Chemical Analysis of Water and Wastes," 1971, Environmental Protection Agency, Water Quality Office, Cincinnati, Ohio 45202, p. 53.

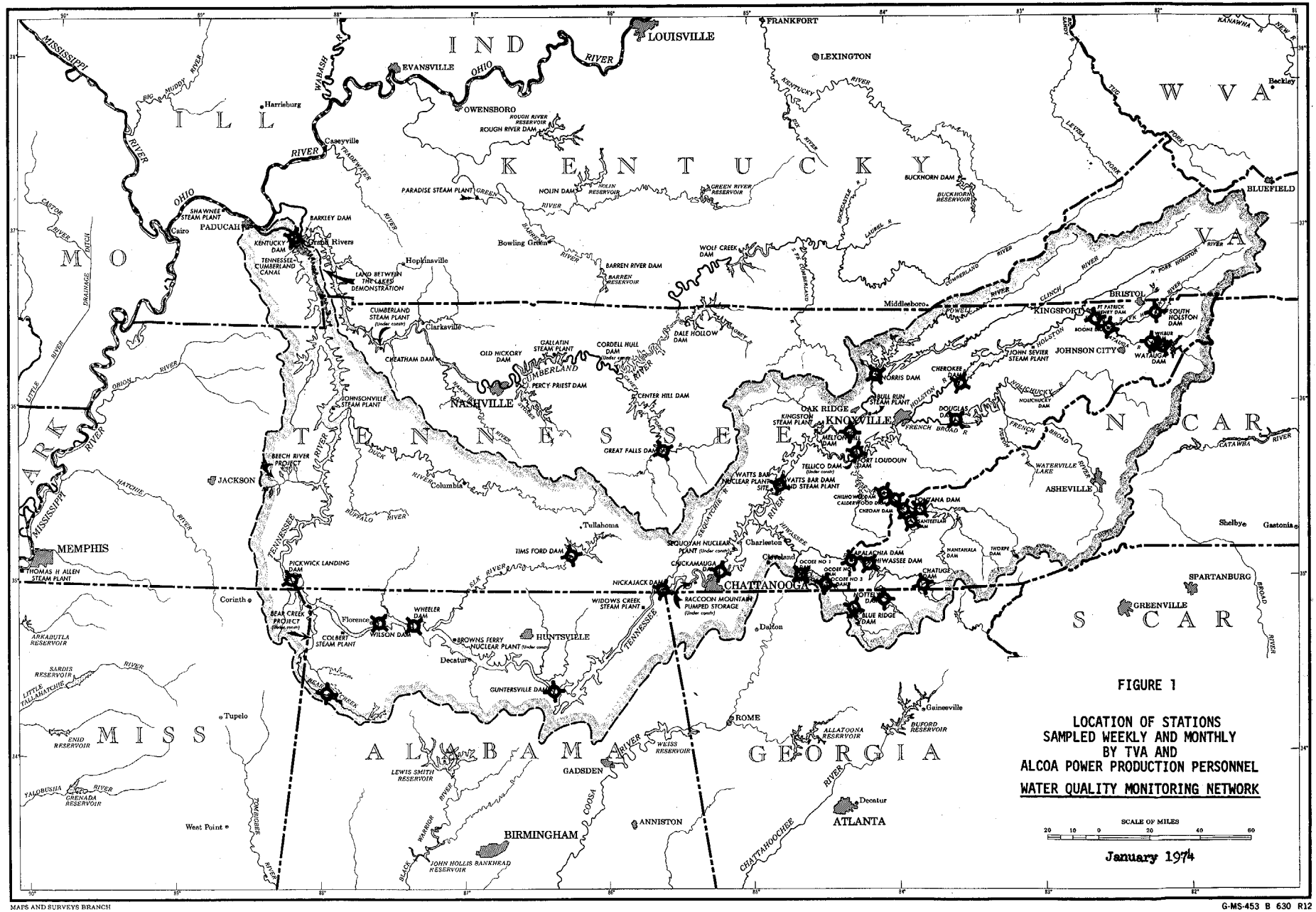
Table 1

Location of Stations Sampled Weekly and Monthly
by TVA and Alcoa Power Production Personnel

WATER QUALITY MONITORING NETWORK

STORET Sta. Code	Stream	Mile	Description[a]	State
202854	Tennessee River	22.4	Kentucky Dam, tailrace	KY
475002	Tennessee River	206.7	Pickwick Dam, tailrace	TN
016999	Tennessee River	259.4	Wilson Dam, tailrace	AL
017001	Tennessee River	274.9	Wheeler Dam, tailrace	AL
016909	Tennessee River	349.0	Guntersville Dam, tailrace	AL
475524	Tennessee River	424.7	Nickajack Dam, tailrace	TN
475525	Tennessee River	471.0	Chickamauga Dam, tailrace	TN
475364	Tennessee River	529.9	Watts Bar Dam, tailrace	TN
475502	Tennessee River	602.3	Fort Loudoun Dam, tailrace	TN
017015	Bear Creek	74.3	Bear Creek Dam, 1,500' downstream[b]	AL
475687	Elk River	133.3	Tims Ford Dam, scroll case	TN
475558	Hiwassee River	53.5	Apalachia Powerhouse, penstock	TN
360222	Hiwassee River	75.8	Hiwassee Dam, scroll case	NC
360223	Hiwassee River	121.0	Chatuge Dam, scroll case	NC
475529	Ocoee River	11.9	Ocoee No. 1 Dam, scroll case	TN
475235	Ocoee River	25.0	Ocoee No. 3 Powerhouse, scroll case	TN
120842	Toccoa (Ocoee) River	53.0	Blue Ridge Dam, scroll case	GA
120841	Nottely River	21.0	Nottely Dam, penstock	GA
475115	Clinch River	23.1	Melton Hill Dam, tailrace	TN
475114	Clinch River	79.8	Norris Dam, scroll case	TN
475388	Little Tennessee River	33.6	Chilhowee Dam, penstock	TN
475526	Little Tennessee River	42.5	Calderwood Powerhouse, penstock	TN
360216	Little Tennessee River	51.4	Cheoah Dam, penstock	NC
360116	Little Tennessee River	61.0	Fontana Dam, scroll case	NC
360217	Cheoah River	9.3	Santeetlah Powerhouse, tailrace[c]	NC
475069	Holston River	52.3	Cherokee Dam, scroll case	TN
475120	South Fork Holston River	8.2	Fort Patrick Henry Dam, scroll case	TN
475151	South Fork Holston River	18.6	Boone Dam, scroll case	TN
475527	South Fork Holston River	49.8	South Holston Dam, scroll case	TN
475557	Watauga River	34.0	Wilbur Dam, scroll case	TN
475528	Watauga River	35.8	Watauga Powerhouse, penstock	TN
475088	French Broad River	32.3	Douglas Dam, scroll case	TN
600017	Caney Fork River[d]	90.6	Great Falls Powerhouse, scroll case	TN

a. With the exception of Bear Creek Dam, which has no power generating facilities, the sampling point is located at the power plant. When the term "dam" is used, it means the powerhouse is located at the dam; the term "powerhouse" is used when the power plant is located separate from the dam.
b. Collected by Hydraulic Data Branch personnel.
c. Santeetlah Powerhouse takes water from Santeetlah Reservoir (dam at Cheoah River mile 9.3) through a 25,180-foot tunnel and pipeline, and discharges into the Little Tennessee River at mile 56.8 (Cheoah Reservoir).
d. TVA plant in the Cumberland River basin.



MAPS AND SURVEYS BRANCH

G-MS-453 B 630 R12

Table 2

List of Analyses
For Samples Collected on Monthly Frequency

WATER QUALITY MONITORING NETWORK

STORET Code No.	Parameter[a]	Reporting Units	Minimum Detectable Amount[b]
00010	Temperature[c]	°C	NA
00300	Dissolved oxygen[c]	mg/l as O_2	0.1
00400	pH	Standard units	NA
00410	Alkalinity, total	mg/l as $CaCO_3$	1
00415	Alkalinity, phenolphthalein	mg/l as $CaCO_3$	1
00515	Residue, total filterable (dissolved solids, 180°C)	mg/l	10
00530	Residue, total nonfilterable (suspended solids, 105°C)	mg/l	1
00095	Conductance, specific	μmhos/cm at 25°C	0.5
00080	Color, true	Platinum Cobalt Units	5
00081	Color, apparent	Platinum Cobalt Units	5
00070	Turbidity	Jackson Turbidity Units	1
00335	Chemical oxygen demand	mg/l as COD	1
00605	Nitrogen, organic	mg/l as N	0.01
00610	Nitrogen, ammonia	mg/l as N	0.01
00630	Nitrogen, nitrate plus nitrite	mg/l as N	0.05
00665	Phosphorus, total	mg/l as P	0.01
01045	Iron, total	μg/l as Fe	50
01055	Manganese, total	μg/l as Mn	10
00929	Sodium	mg/l as Na	0.1
00937	Potassium	mg/l as K	0.1
00916	Calcium	mg/l as Ca	1
00927	Magnesium	mg/l as Mg	0.1
00900	Hardness, total	mg/l as $CaCO_3$	3
00940	Chloride	mg/l as Cl	1
00951	Fluoride	mg/l as F	0.01
00945	Sulfate	mg/l as SO_4	1
00956	Silica	mg/l as SiO_2	0.1

a. Parameters are listed in the order they will be retrieved from STORET. In addition to the parameters listed, each retrieval automatically will print the date, time, and depth of sample collection. The horizontal location (STORET Code No. 00002) and instantaneous streamflow (Code No. 00061) are also available for all sample collections.
b. NA means not applicable.
c. Temperature and DO are measured weekly at TVA and Alcoa dams.

collections are to be made during the first part of the week (Monday through Wednesday) and that the samples are to be returned promptly by United States mail to reduce the possibility of samples being delayed over a weekend. Samples are collected only when water is passing through the plant. When these two requirements conflict (a not uncommon occurrence), sampling is deferred until the next week. Instructions stiuplate that if sampling would interfere with regular work assignments, sample collection is to be deferred.

Quarterly Sampling at Key Locations

The locations at which samples are collected quarterly are listed in table 3 and shown in figure 2. This listing is current for the first quarter (January through March) of calendar year 1974. During 1973, samples were collected at many of these stations by Water Quality Branch personnel in conjunction with regular work assignments. Samples were not collected from stations inconveniently located with respect to Chattanooga, such as Allen, Shawnee, and Paradise Steam Plants and the upper Clinch and French Broad Rivers, until cooperative sampling arrangements were completed.

The selection of the quarterly sampling frequency was based on the need to balance the number of stations at which sampling is desired with the total number of samples on which the laboratory could, on a long-range basis, perform the large number of analyses specified in table 4. Stations were selected with the following criteria:

1. Main flow of the Tennessee River; TVA dams and steam plants and other convenient intermediate locations.

2. Water intakes at other TVA steam plants, including plants outside the Tennessee Valley, because similar sampling is required for other purposes.

3. Water flowing out of major tributary basins into the Tennessee River; sampling points located at hydroelectric plants or stream gages.

4. Major interstate streams; sampling points located at or near stream gages where the streams flow across state lines.

5. Stations on tributary streams being sampled on a long-term basis for other purposes.

Collection of the quarterly samples involves filling 10 bottles, some of which have preservatives added to ensure stability of parameters. The samples are shipped to the laboratory in Chattanooga using the means most convenient to the shipper. Analyses for coliform bacteria and determination of biochemical oxygen demand (BOD) are included in this part of the sampling program (table 4); therefore, the elapsed time between collection and receipt in the laboratory is critical. A delay of 24 hours is about the limit that is tolerated; if there is a longer delay, these parameters are deleted. When long delays cannot be avoided, or when ice for cooling samples is unavailable, samples for the BOD and coliform analyses are not collected.

Bottles are shipped by UPS to the field locations one week before the desired sampling date. Actual sampling dates are determined by the cooperating personnel to fit the sampling into their regular work schedules as much as practicable.

There is no duplication of sampling for those stations included in both the monthly and quarterly schedules (tables 1 and 3). The more complete quarterly collections replace the regular monthly sampling.

Table 3

Location of Stations Sampled Quarterly

WATER QUALITY MONITORING NETWORK

STORET Sta. Code	Stream	Mile	Description	Collector[a]	State
202854	Tennessee River	22.4	Kentucky Dam, tailrace	DPP	KY
475799	Tennessee River	100.4	Johnsonville Steam Plant, intake	DPP	TN
475002	Tennessee River	206.7	Pickwick Dam, tailrace	DPP	TN
016920	Tennessee River	244.96	Colbert Steam Plant, intake	DPP	AL
016999	Tennessee River	259.4	Wilson Dam, tailrace	DPP	AL
017001	Tennessee River	274.9	Wheeler Dam, tailrace	WQB	AL
017009	Tennessee River	295.87	Browns Ferry Nuclear Plant, above plant	WQB	AL
017095	Tennessee River	306.0	Decatur Water Treatment Plant, intake	WQB	AL
016909	Tennessee River	349.0	Guntersville Dam, tailrace	DPP	AL
017101	Tennessee River	396.8	Bellefonte Nuclear Plant, above plant	WQB	AL
017181	Tennessee River	407.7	Widows Creek Steam Plant, intake	DPP	AL
475524	Tennessee River	424.7	Nickajack Dam, tailrace	WQB	TN
475525	Tennessee River	471.0	Chickamauga Dam, tailrace	WQB	TN
475306	Tennessee River	484.10	Sequoyah Nuclear Plant, above plant	WQB	TN
475364	Tennessee River	529.9	Watts Bar Dam, tailrace	WQB	TN
475502	Tennessee River	602.3	Fort Loudoun Dam, tailrace	DPP	TN
475793	Duck River	26.0	Stream gage above Hurricane Mills	HDB	TN
475763	Duck River	133.9	Columbia Water Treatment Plant, intake	WQB	TN
475761	Duck River	222.0	Shelbyville Water Treatment Plant, intake	WQB	TN
475794	Buffalo River	17.7	Stream gage near Lobelville	HDB	TN
017019	Bear Creek	27.3	Stream gage at Bishop	HDB	AL
475795	Shoal Creek	22.3	Stream gage at Iron City	HDB	TN
475796	Elk River	41.5	Stream gage near Prospect	HDB	TN
475687	Elk River	133.3	Tims Ford Dam, scroll case	WQB	TN
475789	Sequatchie River	25.1	Stream gage near Whitwell	WQB	TN
475558	Hiwassee River	53.5	Apalachia Powerhouse, penstock	DPP	TN
475529	Ocoee River	11.9	Ocoee No. 1 Dam, scroll case	WQB	TN
475115	Clinch River	23.1	Melton Hill Dam, tailrace	DPP	TN
475843	Clinch River	48.6	Bull Run Steam Plant, intake	DPP	TN
475114	Clinch River	79.8	Norris Dam, scroll case	DPP	TN
510265	Clinch River	211.0	Stream gage at Speers Ferry	HDB	TN
475977	Emory River	1.8	Kingston Steam Plant, intake	DPP	TN
475838	Emory River	18.3	Stream gage at Oakdale	HDB	TN
475098	Powell River	65.4	Stream gage near Arthur	HDB	TN
475388	Little Tennessee River	33.6	Chilhowee Dam, penstock	ALCOA	TN
475069	Holston River	52.3	Cherokee Dam, scroll case	DPP	TN
475797	Holston River	106.7	John Sevier Steam Plant, intake	DPP	TN
475120	South Fork Holston River	8.2	Fort Patrick Henry Dam, scroll case	DPP	TN
475151	South Fork Holston River	18.6	Boone Dam, scroll case	DPP	TN
510256	North Fork Holston River	8.8	Stream gage near Gate City	HDB	VA
475088	French Broad River	32.3	Douglas Dam, scroll case	DPP	TN
475086	French Broad River	77.5	Stream gage near Newport	HDB	TN
360204	French Broad River	145.8	Stream gage at Asheville	HDB	NC
475798	Nolichucky River	45.7	Stream gage below Nolichucky Dam	HDB	TN
475087	Pigeon River	6.8	Stream gage at Newport	HDB	TN
			Outside Tennessee Valley		
475800	Mississippi River	725.6	Allen Steam Plant, intake	DPP	TN
202855	Ohio River	(approx.) 36.5	Shawnee Steam Plant, intake	DPP	KY
600033	Cumberland River	103.2	Cumberland Steam Plant, intake	DPP	TN
600036	Cumberland River	244.0	Gallatin Steam Plant, intake	DPP	TN
600037	Cumberland River	262.9	Lebanon Water Treatment Plant, intake	WQB	TN
600038	Cumberland River	313.5	Cordell Hull Dam, tailrace	WQB	TN
600040	Caney Fork	26.6	Center Hill Dam, tailrace	WQB	TN
202856	Green River	100.6	Paradise Steam Plant, intake	DPP	KY

a. Personnel cooperating with the collection of samples are employed in the following organizations:
DPP - Division of Power Production
HDB - Hydraulic Data Branch, Division of Water Control Planning
ALCOA - Aluminum Company of America
WQB - Water Quality Branch, Division of Environmental Planning

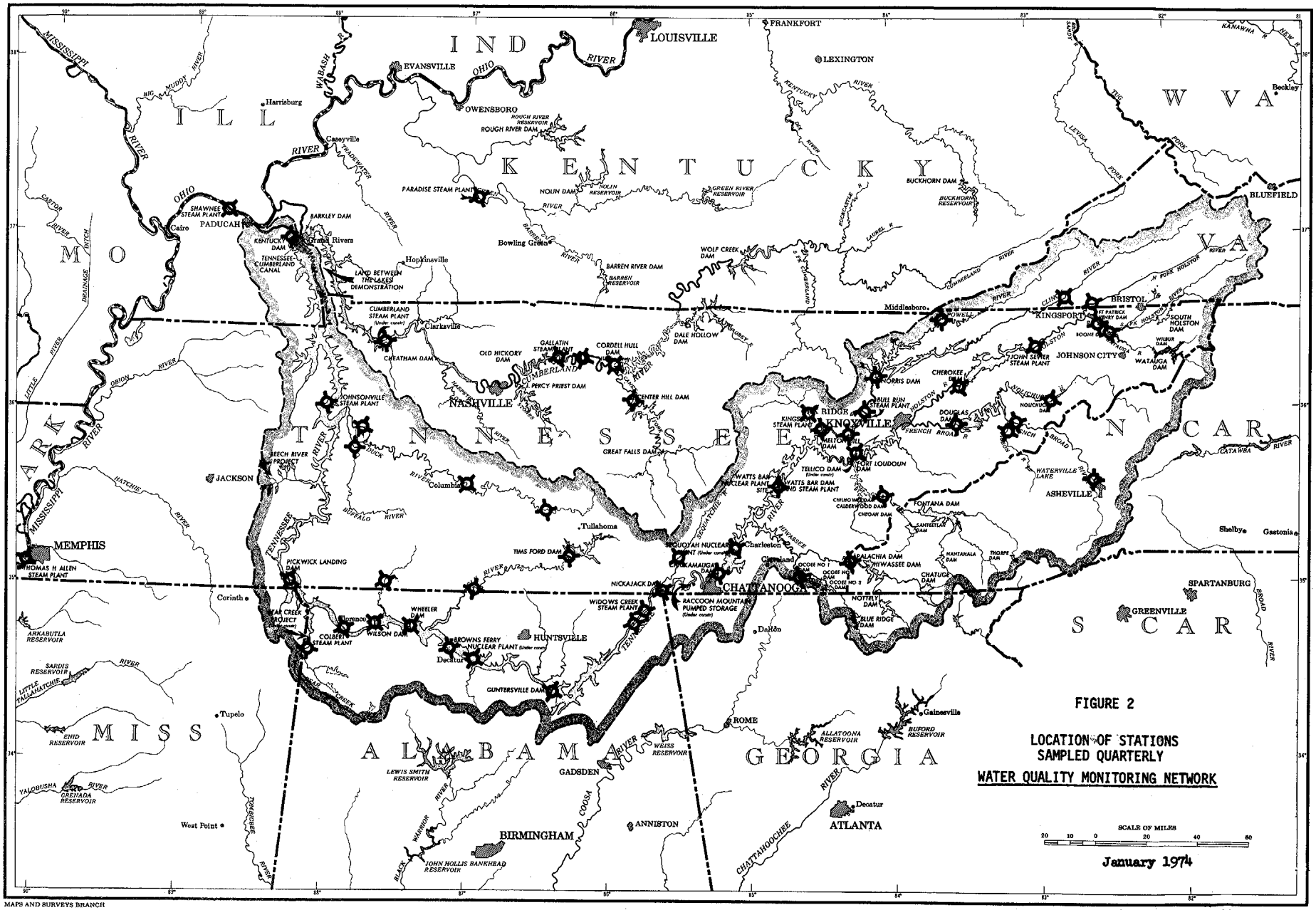


FIGURE 2
LOCATION OF STATIONS
SAMPLED QUARTERLY
WATER QUALITY MONITORING NETWORK
SCALE OF MILES
20 10 0 20 40 60
January 1974
LOUISVILLE
FRANKFORT
LEXINGTON
EVANSVILLE
OWENSBORO
Harrisburg
Caseyville
Beckley
BLUEFIELD
Cairo
PADUCAH
Hopkinsville
Bowling Green
Middlesboro
BRISTOL
KINGSPORT
JOHNSON CITY
Clarksville
NASHVILLE
JACKSON
Columbia
Tullahoma
MEMPHIS
Corinth
Tupelo
West Point
HUNTSVILLE
Decatur
CHATTANOOGA
Dalton
ROME
Gainesville
Shelby
Gastonia
SPARTANBURG
GREENVILLE
ASHEVILLE
BIRMINGHAM
ANNISTON
GADSDEN
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MAPS AND SURVEYS BRANCH
G-MS-453 B 630 R12

Table 4

List of Analyses
For Samples Collected on Quarterly Frequency

WATER QUALITY MONITORING NETWORK

STORET Code No.	Parameter[a]	Reporting Units	Minimum Detectable Amount[b]
00010	Temperature[c]	°C	NA
00300	Dissolved oxygen[c]	mg/l as 0_2	0.1
00400	pH	Standard units	NA
00410	Alkalinity, total	mg/l as $CaCO_3$	1
00415	Alkalinity, phenolphthalein	mg/l as Ca CO_3	1
00515	Residue, total filterable (dissolved solids, 180°C)	mg/l	10
00530	Residue, total nonfilterable (suspended solids, 105°C)	mg/l	1
00095	Conductance, specific	µmhos/cm at 25°C	0.5
00080	Color, true	Platinum Cobalt Units	5
00081	Color, apparent	Platinum Cobalt Units	5
00070	Turbidity	Jackson Turbidity Units	1
31501	Coliform, total	Number/100 ml	1
31616	Coliform, fecal	Number/100 ml	1
00310	Biochemical oxygen demand (5-day, 20°C incubation)	mg/l as BOD	1
00335	Chemical oxygen demand	mg/l as COD	1
00680	Carbon, total organic	mg/l as C	0.2
01045	Iron, total	µg/l as Fe	50
01055	Manganese, total	µg/l as Mn	10
00605	Nitrogen, organic	mg/l as N	0.01
00610	Nitrogen, ammonia	mg/l as N	0.01
00630	Nitrogen, nitrate plus nitrite	mg/l as N	0.05
00665	Phosphorus, total	mg/l as P	0.01
00929	Soidum	mg/l as Na	0.1
00937	Potassium	mg/l as K	0.1
00916	Calcium	mg/l as Ca	1
00927	Magnesium	mg/l as Mg	0.1
00900	Hardness, total	mg/l as $CaCO_3$	3
00940	Chloride	mg/l as Cl	1
00951	Fluoride	mg/l as F	0.01
00945	Sulfate	mg/l as SO_4	1
00956	Silica	mg/l as SiO_2	0.1
01105	Aluminum	µg/l as Al	200
01002	Arsenic	µg/l as As	5
01007	Barium	µg/l as Ba	100
01012	Beryllium	µg/l as Be	10
01022	Boron	µg/l as B	100
01027	Cadmium	µg/l as Cd	1
01034	Chromium, total	µg/l as Cr	5
01042	Copper	µg/l as Cu	10
01051	Lead	µg/l as Pb	10
01132	Lithium	µg/l as Li	10
71900	Mercury	µg/l as Hg	0.2
01067	Nickel	µg/l as Ni	50[d]
01147	Selenium	µg/l as Se	1
01077	Silver	µg/l as Ag	10[d]
01152	Titanium	µg/l as Ti	1,000
01092	Zinc	µg/l as Zn	10

a. Parameters are listed in the order they will be retrieved from STORET. In addition to the parameters listed, each retrieval automatically will print the date, time, and depth of sample collection. The horizontal location (STORET Code No. 00002) and instantaneous streamflow (Code No. 00061) are also available for all sample collections.
b. NA means not applicable.
c. Temperature and DO are measured weekly at TVA and Alcoa dams.
d. Minimum detectable amount shown is attained by direct analysis of the sample; much lower values can be achieved with extraction procedures.

Monthly Sampling at Tributary Stream Locations

Monthly sampling of tributary streams is designed to give the monitoring network flexibility and to make it more responsive to short-term data needs. Stations are reevaluated annually and are usually intended to be sampled monthly for only one year. The sampling period for this work is on a "water year" basis (October through September). Those who potentially would have use for water quality data will be given an opportunity each year to suggest sampling locations and to specify needs that may be filled by this activity. Potential users include TVA (resource development and power programs) and other governmental agencies. Should a continuing need for data at any station be identified, it may be retained under this monthly sampling activity or designated as a new key station (table 3) and sampled quarterly.

The locations of stations being sampled during the 1974 water year are listed in table 5 and shown in figure 3. This activity is carried out with the cooperation of the TVA Hydraulic Data Branch, which has personnel experienced in techniques of data collection who are strategically located in field offices throughout the area (figure 3). Consequently, selection of sampling locations essentially is not limited except as it conflicts with other work for which the Hydraulic Data Branch is responsible.

Logistics and Control

Shipping and Receiving—Approximate sample collection dates are controlled by the shipment of bottles to field locations during the week before the desired date of sampling. Bottles are shipped by United Parcel Service via the TVA mail generally on the first workday of the week. These shipments are scheduled to provide an even flow of samples returning to the laboratory to help equalize the workload. An example of this scheduling is outlined in table 6.

The Chattanooga bus stations are checked each workday morning for arriving sample packages. Shipments that arrive later during the day are picked up promptly after notification is received from the bus company. Samples also are returned via United Parcel Service and United States mail and are delivered to the laboratory by the TVA mail service.

Quality Control—A system of quality control will be initiated during calendar year 1974 to assess the reliability of the data collection program. This quality control system involves the collection of one duplicate set of samples for every 10 to 20 regularly scheduled samples. Laboratory analyses are then replicated on both samples of the duplicate, and the four results are compared to assess sampling and analytical precision. Known amounts of chemicals are added to aliquots of samples, and these "spiked" aliquots are then analyzed to determine the amounts of their known contents that can be recovered. Any differences found may be ascribed to sampling and handling techniques, analytical precision, procedural accuracy, possible interferences, or natural variability. The duplicate sampling scheme is diagramed in figure 4.

The extra work required for quality control includes one extra sample collection per year at each hydroelectric plant and each steam plant. This amounts to an extra two or three samples each month for the laboratory. Quality control sampling will include the Hyraulic Data Branch activity. Since these personnel also are equipped to perform selected analyses in the field, in addition to the duplicate sampling the system will include the periodic use of reference and unknown samples sent for analysis.

Table 5

Location of Stations Sampled Monthly
by TVA Hydraulic Data Branch Personnel

WATER QUALITY MONITORING NETWORK

Water Year 1974

STORET Sta. Code	Stream	Mile	Description	State
475839	Tennessee River	157.8	At Clifton Ferry	TN
475840	Buffalo River	58.7	Stream gage near Flat Woods	TN
475180	Beech River	34.8	Highway 104 bridge near Lexington	TN
280002	Yellow Creek	15.7	Moser Bridge near Doskie	MI
017016	Bear Creek	113.9	Highway bridge at Bear Creek	AL
017020	Cedar Creek	19.1	Stream gage near Pleasant Site	AL
017021	Little Bear Creek	4.3	Stream gage near Halltown	AL
475627	Elk River	93.9	Stream gage above Fayetteville	TN
475049	Elk River	167.3	Stream gage near Estill Springs	TN
475062	Hiwassee River	42.6	Harbinson Bridge, U.S. Highway 411	TN
475842	Hiwassee River	62.6	Highway 68 bridge at Apalachia	TN
475843	Clinch River	48.6	Bull Run Steam Plant, intake	TN
475844	Clinch River	58.8	Stream gage (Highway 25) at Clinton	TN
475845	Clinch River	66.3	Highway 61 bridge near Clinton	TN
475846	Clinch River	159.8	Stream gage above Tazewell	TN
475847	Clinch River	189.8	Highway 70 bridge at Kyles Ford	TN
475139	Obed River	24.9	Adams Bridge	TN
475616	Ollis Creek	0.24	LaFollette Reservoir	TN
510190	Powell River	177.8	Bridge at Cadet, near Big Stone Gap	VA
510169	North Fork Powell River	1.9	Bridge above Dry Branch, near Pennington Gap	VA
475848	Tellico River	28.2	Stream gage at Tellico Plains	TN
360121	Tuckasegee River	24.3	Bridge at Wilmot	NC
360233	Tuckasegee River	31.6	Above Scott Creek, at Dillsboro	NC
360126	Scott Creek	2.2	City Hall Bridge at Sylva	NC
360127	Scott Creek	3.9	Road crossing at Liberty School	NC
475849	Holston River	39.9	At Indian Cave	TN
475070	Holston River	118.4	Bridge at Surgoinsville	TN
475071	Holston River	131.5	Bridge at Church Hill	TN
510155	Middle Fork Holston River	21.6	Bridge near Glade Spring	VA
360234	French Broad River	125.1	Stream gage at Marshall	NC
360167	French Broad River	165.3	Flanning Bridge near Fletcher	NC
360068	French Broad River	183.7	Stream gage at Blantyre	NC
360163	Pigeon River	42.8	Below I 40 Highway bridge	NC
	Outside Tennessee Valley			
202861	Green River	99.8	Below former ferry at Paradise	KY

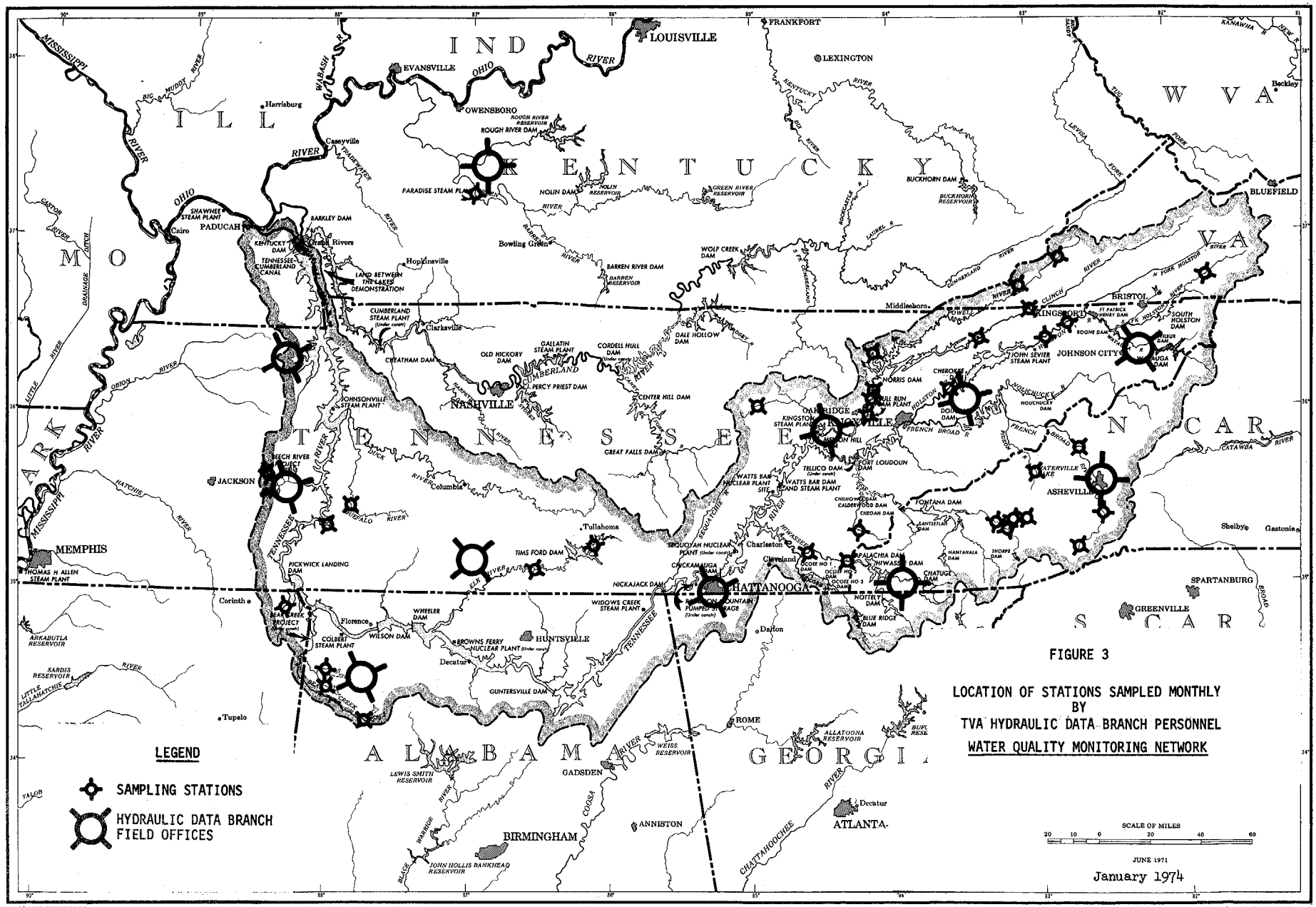

FIGURE 3

LOCATION OF STATIONS SAMPLED MONTHLY
BY
TVA HYDRAULIC DATA BRANCH PERSONNEL
WATER QUALITY MONITORING NETWORK

MAPS AND SURVEYS BR.

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Table 6

Sample Bottle Shipping Schedule

WATER QUALITY MONITORING NETWORK

	Month 1	Month 2	Month 3
Week 1	Quarterly sample bottles shipped to steam plants No. of plants = 11	Quarterly sample bottles shipped to Hyd. Data Br. No. of stations = 13	Quarterly sample bottles shipped to hydro plants No. of plants = 13
Week 2	Monthly sample bottles shipped to hydro plants No. of plants = 32	Monthly sample bottles shipped to hydro plants No. of plants = 32	Monthly sample bottles shipped to hydro plants No. of plants = 19
Week 3	Reserved for special samples	Reserved for special samples	Reserved for special samples
Week 4	Monthly sample bottles shipped to Hyd. Data Branch No. of stations = 35	Monthly sample bottles shipped to Hyd. Data Branch No. of stations = 35	Monthly sample bottles shipped to Hyd. Data Branch No. of stations = 35

NOTE: Additional sampling other than the network activity (and therefore not shown in this table) is incorporated into the shipping scheme.

Data Reporting

The data collected by the water quality monitoring network will be available to users in a number of ways. All data are routinely entered into the national data storage and retrieval system (STORET) operated by EPA and therefore are readily available to those who have access to the system. Data collected by TVA are used directly from the STORET system by EPA and the Valley states and probably others. No record of such use is available, but the extent of this use is believed to be substantial.

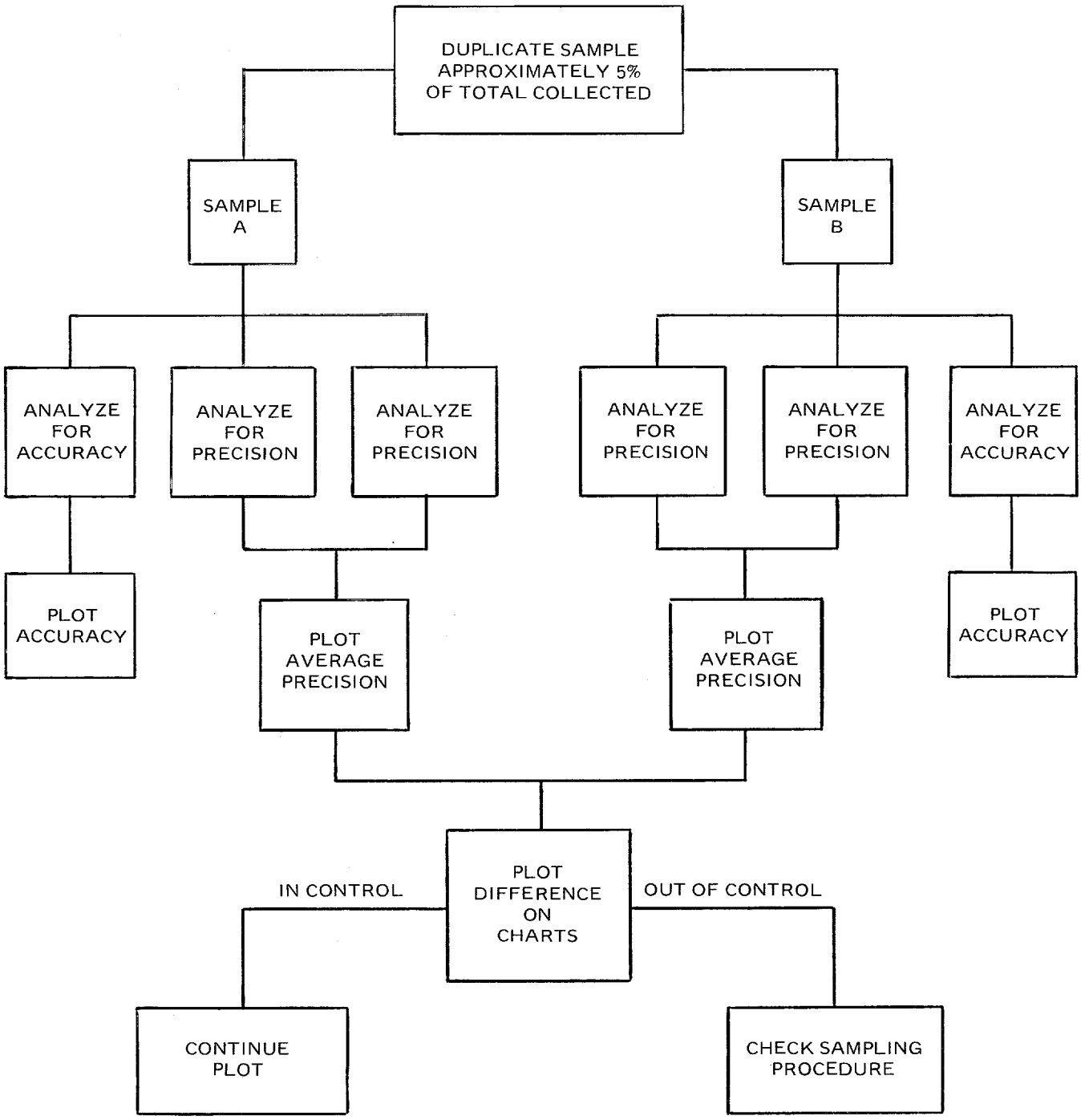
The requests for data that are frequently received by letter or telephone can be promptly filled by supplying copies of data printouts (STORET) kept on file in the Water Quality Branch. Much of the information collected by the Water Quality Branch is distributed in this way to fill specific needs, and there will be a continuing need to distribute data in this way.

The data obtained on tributary streams from monthly sample collections (table 5) will be reported through the USGS in their annual "Water Resources Data" publications for the Valley states. Other network data also will be furnished to the USGS and other agencies for publication upon request.

The Water Quality Branch plans to report annually, on a calendar year basis, a summary describing the data that have been obtained through the report date. The format of the report will be designed to utilize directly, as far as possible, automatic typewriting equipment, data retrieval capabilities of the STORET system and a computer time-sharing terminal with an automatic plotting capability. The description of how the monitoring network functions, the locations of stations, the list of parameters, and the references of analytical procedures should change little from one report to the next, and consequently, the report can be organized for maximum utilization of such automatic equipment.

Figure 4

DUPLICATE SAMPLE ANALYSIS SCHEME
TO ENSURE QUALITY CONTROL
WATER QUALITY MONITORING NETWORK



The annual report will be designed to inform users about what water quality data are available and to assist them in obtaining the data they need. It will be distributed initially to users in TVA and other Federal and state agencies known to have a need for such information. A permanent distribution list will be maintained by adding names as new users are identified. The mailing list will be kept up to date by sending out with each report a reply card that will require each recipient to reaffirm his continuing need for the annual report. Name and address changes can be updated with the same card.

Contact with data users will be maintained by including on the reply card an invitation for each recipient to identify specific needs (locations, parameters, frequencies) that are not being filled by the network activity. This feedback can be coordinated with other data collecting organizations to promote maximum effectiveness. In this way, the Water Quality Branch will be able to evaluate the success of the monitoring network activity and to anticipate potential needs. The network is designed to fill a variety of needs, but since needs continually change, the network must also change if it is to fulfill its purpose.